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NUCLEAR WASTE
CLEANUP

DOE's Cleanup Plan for
the Paducah, Kentucky
Site Faces Uncertainties
and Excludes Costly
Activities

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss the Department of Energy's (DOE) efforts to clean up its Paducah, Kentucky, uranium enrichment plant. Recent allegations that past activities at the plant endangered the health of employees led to renewed interest in DOE's efforts to clean up the site—efforts that began in 1988, when contamination was discovered in the drinking water wells of residences near the plant. Allegations include the improper disposal of hazardous and radioactive materials, release of contamination into streams and drainage ditches, and exposure of workers to radioactive materials. In an October 1999 report on Paducah, DOE found that limited progress has been made in cleaning up the source areas of contamination at the site, such as landfills, waste burial grounds, and waste and scrap piles.¹

Our statement today, based on our April 28, 2000, report,² addresses three issues: (1) DOE's planned activities, cost, and schedule for cleaning up the site; (2) the challenges in accomplishing the current cleanup plan; and (3) whether the cleanup plan includes all areas at the site requiring cleanup.

In summary:

- DOE expects to complete the cleanup by 2010 at a cost of about \$1.3 billion (in addition to the nearly \$400 million spent over the past decade on the characterization of the contamination on site and mitigation efforts, such as connecting residences with contaminated drinking water to municipal water). DOE's cleanup plan focuses on six major categories of cleanup. Four of these address the physical contamination at the site: about 10 billion gallons of groundwater contaminated with radioactive

¹Phase I: Independent Investigation of the Paducah Gaseous Diffusion Plant (Office of Oversight; Office of Environment, Safety and Health; Department of Energy; Oct. 1999).

²Nuclear Waste Cleanup: DOE's Paducah Plan Faces Uncertainties and Excludes Costly Cleanup Activities (GAO/RCED-00-96, Apr. 28, 2000).

and hazardous materials, contaminated surface water in creeks and ditches leaving the site, contamination in soils that may be spread by rain, and tons of buried waste. The two other major categories include treating and disposing of the equivalent of about 52,000 barrels of waste and decontaminating and removing two unused process buildings.

- Numerous technical, funding, and regulatory uncertainties present challenges to DOE's ability to complete the cleanup as planned. Technical uncertainties include the planned use of technologies that are unproven or perhaps not well suited to the site's conditions. Also underpinning the plan is the assumption that federal funding for cleanup at Paducah will increase to an average of \$124 million annually over the next decade, compared with the last 7 years' annual average funding of \$43 million. The plan also includes optimistic assumptions about reaching agreement with regulators on issues such as cleanup levels, strategies, and priorities.
- Finally, even when the planned cleanup has been carried out, billions of dollars and many years will be needed to address areas at the Paducah site that are not in the cleanup plan. For example, almost 500,000 tons of depleted uranium will need to be converted to a more stable form and removed from the site. In addition, the plan excludes nearly a million cubic feet of waste and scrap in areas known as DOE Material Storage Areas (DMSA) and 16 unused and inactive buildings and structures. Some of the waste and scrap material pose a risk of an uncontrolled nuclear reaction that could threaten worker safety. Such a reaction produces a burst of radiation that generally lasts several hours; it is, however, a localized event that would not result in an explosion or release of radioactivity into the atmosphere. The additional materials, buildings and structures are excluded from the plan not because they require no action but because they fall under the purview of a different departmental program. The DMSAs and the 16 excess buildings and structures are the responsibility of DOE's Office of Nuclear Energy, Science, and Technology (Office of Nuclear Energy), while the site cleanup is the Office of Environmental Management's

responsibility. This programmatic distinction prevents the Paducah cleanup managers from assessing risk or planning cleanup on a comprehensive, sitewide basis, and distorts the picture of the cleanup task at hand. As a result, we recommended in our report that these areas be transferred from the Office of Nuclear Energy to the Office of Environmental Management. We also recommended that the cleanup plan address all materials at the site that are potential health hazards, regardless of organizational responsibility, and that sitewide contamination risk and cleanup priorities, cost, and schedules be reexamined.

Background

The Paducah uranium enrichment plant is located in western Kentucky, about 3 miles south of the Ohio River and about 10 miles west of the city of Paducah. The plant—formerly run by DOE and now operated by a private company, the United States Enrichment Corporation (USEC)—enriches uranium for commercial nuclear power plants. Plant operations have contaminated the site over time with radioactive and hazardous chemical wastes, including technetium-99 (a radioactive fission product), polychlorinated biphenyls (PCBs), uranium, and volatile organic compounds such as trichloroethene (used as a degreaser).

DOE's management of the Paducah site is divided between two offices. The Office of Environmental Management is responsible for the site's cleanup, while the Office of Nuclear Energy acts as the site's "landlord," with responsibilities for maintaining roads, grounds, and facilities not leased to USEC and for managing material storage areas and cylinders of depleted uranium. Cleanup activities are managed under contract by Bechtel Jacobs. Other stakeholders include the Environmental Protection Agency (EPA) and the Commonwealth of Kentucky, both of which have regulatory responsibilities and participate in cleanup decisions.

Two federal environmental statutes govern the cleanup of the Paducah site. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, commonly known as Superfund, provides broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. The Resource Conservation and Recovery Act of 1976 applies to the safe management and disposal of hazardous or other solid wastes.

Specific cleanup strategies, their cost estimates, and time frames for completion are included in lifecycle baselines prepared by the site contractor, Bechtel Jacobs. The lifecycle baseline, according to DOE and contractor officials, is a "living document;" it is updated frequently to reflect the evolving nature of the cleanup process. Revisions to the lifecycle baseline are made to incorporate such things as changes in funding; updated cost estimates for specific studies, tests, and cleanup tasks; and changes in project approach or scope necessitated by study results. Such revisions can affect estimates of the total cost and schedule. We examined activities, costs, and schedules contained in the January 26, 2000, version of the lifecycle baseline.

**DOE Plans to Clean Up Six Major
Categories by 2010 at a Cost of About
\$1.3 Billion**

DOE's January 2000 plan divides cleanup activities into six major categories—groundwater, surface water, surface soils, burial grounds, 52,000 barrels of accumulated wastes, and removal of two unused process buildings. DOE plans to complete its cleanup by 2010 at a cost of approximately \$1.3 billion. Table 1 shows, by cleanup category, the planned cleanup cost and completion date.

Table 1: DOE's Estimated Cost and Schedule for Six Cleanup Categories at the Paducah Site, as of January 2000

Dollars in thousands

Cleanup category	Cleanup cost	Completion date
Groundwater	\$ 162,100	2006
Surface water	162,300	2007
Surface soils	19,000	2007
Burial grounds	535,400	2010
Waste barrels (52,000)	228,100	2010
Unused process buildings	92,100	2008
Other ^a	104,200	2011
Total	\$1,303,200	

^aIncludes approximately \$91 million for monitoring and maintaining the site and about \$13 million for other activities in 2011, such as preparing post-cleanup reports.

Source: DOE.

Taken together, the scope of the planned cleanup activities for the six categories is immense. First, three plumes of groundwater contaminated with radioactive and hazardous materials is flowing toward the Ohio River. The plumes contain an estimated 10 billion gallons of groundwater tainted with trichloroethene and 250 million gallons tainted with radioactive technetium-99, a fission product. Trichloroethene in the groundwater has been found at levels of up to 700,000 parts per billion; the drinking water standard is 5 parts per billion. DOE has connected nearby residences to municipal drinking water and constructed groundwater pump-and-treat systems to reduce the contamination of two of the plumes. DOE is considering the use of cleanup technologies to remove the sources of groundwater contamination and to remove the contamination from the groundwater.

Second, surface water contamination has been discovered in surrounding creeks and ditches. One of the main sources of this contamination is the thousands of tons of contaminated scrap metal that DOE has stored on site. During rainstorms, contamination washes from the scrap metal, and the runoff carries contaminated soils and sediments into the ditches and creeks. Contamination also stems from the discharge of wastewater from plant operations. Interim measures have included treating some

wastewater and rerouting wastewater around contaminated ditches. DOE's planned cleanup tasks include removing the 65,000 tons of scrap metal, dredging ditches and creeks, and installing basins to catch, and thus allow treatment of, the contaminated water.

Third, surface soils on- and off-site have been contaminated by water runoff, spills, and buried waste. DOE has identified 72 areas with contaminated soils and has taken interim measures, such as installing erosion control fences, to prevent further migration of the contamination. DOE's planned cleanup tasks include excavating and disposing of about 35,000 cubic yards of soil and continuing the use of an innovative technology to clean the soil at one highly contaminated area.

The fourth cleanup category consists of 12 waste burial grounds that contain a variety of contaminants, including arsenic, beryllium, PCBs, trichloroethene, and pyrophoric uranium, which has a tendency to spontaneously combust in the presence of oxygen. The estimated contents of one of these burial grounds include 450 gallons of trichloroethene, 59,000 gallons of oils, and 270 tons of uranium. DOE is planning to excavate four or five of these areas and install a protective cover, or cap, over the remaining areas.

The fifth category consists of the equivalent of 52,000 barrels of waste stored in various locations.³ The majority of these barrels contain hazardous chemicals or materials with low levels of radioactivity. Over 12,000 of these waste barrels are stored outdoors and are deteriorating. DOE has disposed of only about 750 barrels of waste in the past 10 years. Before it can ship the remaining barrels offsite, DOE must characterize and repack most of them to make the barrels suitable for disposal.

³ This waste is stored in a variety of containers, such as 55-, 85-, and 110-gallon barrels. The total volume of waste stored at the Paducah site is equivalent to the volume of about 52,000 55-gallon barrels.

Finally, two process buildings that have not been used as part of the uranium enrichment process since 1977 will be decontaminated and removed. These two buildings are heavily contaminated from earlier operations.

DOE Faces Challenges in Achieving Its Cleanup Plan

A number of technical, financial, and regulatory factors associated with the implementation of the cleanup plan make it uncertain whether DOE can accomplish the Paducah cleanup within the targeted costs and time frames. Uncertainties exist about the nature and extent of contamination and the feasibility of cleanup technologies. In addition, assumptions about the availability of federal funding and the timeliness of stakeholders' agreement with cleanup levels and strategies may affect DOE's ability to meet the plan's milestones.

Uncertainties about the nature, extent, and sources of contamination could affect the cleanup plan; the outcome of such uncertainties could increase cleanup costs. For example, the full extent of contamination in the surface water and soils within and outside the plant boundaries remains to be determined and could affect cleanup strategies, including the number of sedimentation basins that will need to be installed. The basins are intended to collect storm water runoff and will allow the treatment of any contaminants the runoff may contain. The state has expressed its preference for installing eight or nine sedimentation basins, while DOE has only budgeted for four of them and is deferring installation plans until it has finished investigating the extent of contamination. Similarly, although DOE's plan calls for excavating four waste burial grounds, a recent report from the Commonwealth of Kentucky has recommended excavating seven burial grounds.⁴

Technical uncertainties related to the use of cleanup technologies also exist. Some of the technologies contemplated for use are emerging technologies, and others remain

⁴Report of the Commonwealth of Kentucky's Task Force Examining State Regulatory Issues at the Paducah Gaseous Diffusion Plant. Commonwealth of Kentucky, Apr. 2000.

untested for the specific environment found at Paducah. For example, it is uncertain whether the primary treatment planned for groundwater contamination will be successful. DOE plans to implement two key strategies for groundwater cleanup: (1) remove or reduce the sources of the contamination and (2) treat the contaminated groundwater as it migrates offsite. To treat the sources of groundwater contamination, DOE plans to use a technology called dynamic underground stripping. This technology injects steam into the aquifer to volatilize the trichloroethene and cause it to rise to the surface, where it is extracted. According to EPA officials, however, difficulties with steam injection were encountered at another site, and there are questions about whether the technology will work at the Paducah site because of the complex geologic formation.

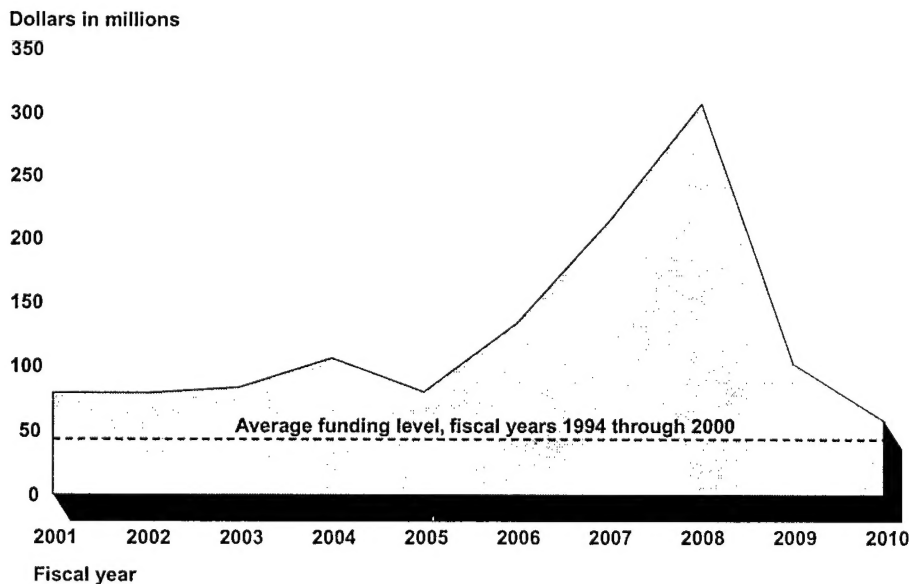
DOE's ability to treat the contaminated groundwater plumes is also uncertain. DOE plans to install over 4,000 feet of permeable treatment barriers across the paths of the highest concentrations of contamination within the plumes. Installing barriers involves injecting a gelatinous, gummy substance called guar gel—at depths of up to 120 feet—into the aquifer. The gel contains iron filings that serve as the treatment zone. In theory, as the groundwater moves through a barrier's treatment zone, the iron filings will chemically react with the trichloroethene, rendering it harmless, and will attract and hold the technetium-99. As planned, the barriers will intercept portions of the groundwater plume with high levels of contaminants while portions of the plume with lesser concentrations will be left untreated.

The permeable treatment barrier technology is quite new, and the potential for its success at the Paducah site is uncertain. The success of the barrier depends on numerous factors, including the rate of groundwater flow, the length of time the water resides in the treatment zone, the level of contamination, and the permeability of the barrier compared to that of the surrounding geologic structure. If groundwater flows too quickly through the barrier and thus spends too little time in the treatment zone, the iron filings might not have time to fully treat the trichloroethene. In that case, the actions of the barrier's treatment zone could change the contaminant to vinyl chloride, which is

more toxic than trichloroethene. Furthermore, it is uncertain how long the other principal contaminant, technetium-99, will adhere to the iron filings in the barrier.

In addition to the technical uncertainties, the cleanup plan is also built on some optimistic financial assumptions. For example, the plan assumes DOE will receive funding for cleanup that is considerably higher than it had received in the past. According to DOE, contractor, and regulatory officials, funding constraints have always been an issue, and their recurrence could delay the project and add to its ultimate costs. For fiscal years 2001 through 2010, DOE cleanup estimates range from a low of \$78 million in 2001 to a high of \$307 million in 2008, or an average of \$124 million a year. In contrast, over the past 7 fiscal years, the site has received funding ranging from about \$36 million to about \$52 million, and averaging \$43 million each year. Figure 1 compares DOE's funding projections through 2010 with this average funding.

Figure 1: Funding Estimates for Fiscal Years 2001 Through 2010, Compared to Previous Average



Source: GAO's analysis of DOE's data.

The cleanup plan also contains optimistic assumptions about the timely achievement of regulatory and stakeholder agreement on cleanup levels, strategies, and priorities. The lack of timely agreement could slow the cleanup and increase the costs. In the past, regulators and stakeholders have disagreed with various aspects of DOE's cleanup plan, and the disagreements have resulted in alterations that have been time-consuming and at times costly. For example, DOE cleaned up an area with PCBs in the soils to EPA's standard of 25 parts per million for open or unoccupied areas. Kentucky objected, however, saying that it wanted the PCBs in the soils cleaned up to 1 part per million, EPA's standard for occupied areas (e.g. industrial or residential use). The parties agreed to defer the resolution of this issue until DOE submits its plans for surface water cleanup. The state has put DOE on notice, however, that it wants a stringent cleanup level for the surface water in order to protect the ecosystem. If DOE adopts a more stringent cleanup level than currently planned, its costs to complete the effort will grow.

Cleanup Plan Does Not Address All Areas that Require Cleanup

Even when the planned cleanup has been carried out, billions of dollars and many years more will be needed to address areas at the site not currently included in the cleanup plan. These areas are excluded not because they require no action but because they fall under the managerial jurisdiction of DOE's Office of Nuclear Energy rather than its Office of Environmental Management. This programmatic distinction between the two offices prevents the Paducah cleanup managers from assessing risk or planning cleanup on a comprehensive sitewide basis. Specifically, four areas are excluded from the plan and will need to be addressed before site cleanup can be considered complete: (1) large amounts of waste and scrap materials, (2) various unused buildings and structures, (3) thousands of tons of depleted uranium, and (4) the buildings and equipment currently being used in the enrichment process that will require cleanup when the plant closes.

The cleanup plan excludes nearly a million cubic feet of waste and scrap contained in 148 DOE Material Storage Areas, or DMSAs, located across the site—some indoors, some outdoors. The materials in these areas include thousands of barrels of low-level

radioactive waste, PCB waste, and asbestos waste; contaminated process equipment; various items and containers whose contents are unknown; and scrap metal. DOE has not yet determined the exact nature and extent of contamination in these areas, but it has identified 73 of them as posing a risk of an uncontrolled nuclear reaction (a burst of radiation that generally lasts several hours). DOE officials said they plan to pay USEC nearly \$5 million to conduct a nuclear criticality safety review on the 10 DMSAs posing the highest risk. However, this does not address the need for a review of the other DMSAs that DOE has identified as having nuclear criticality safety concerns. Nor are cost or schedule estimates in place for characterizing all the DMSAs to determine whether they contain material regulated under federal environmental statutes. According to the DOE official responsible for these areas, the DMSAs have not been transferred to the Office of Environmental Management because DOE is hesitant to transfer any more areas to it. The Office of Environmental Management already has a large workload, and funding for cleanup is limited. However, because the DMSAs have not been transferred to the Office of Environmental Management, they could impede the progress of the cleanup schedule. For example, one of the DMSAs is located on top of a burial ground included in the cleanup plan, but the cleanup plan does not include cost or schedule estimates for removing the DMSA material. Furthermore, DOE officials could not provide any assurances that the material in the DMSAs, if not characterized and removed prior to the completion of the site cleanup, would not recontaminate any cleaned up areas.

The cleanup plan also excludes 16 unused buildings and structures. These buildings and structures, which were originally used as part of the enrichment process, include a sludge lagoon, two water storage tanks, a nitrogen generation plant, and an incinerator. According to DOE officials, lack of funding and higher priorities have prevented these buildings and structures from being transferred to the Office of Environmental Management for cleanup.

Before the site is considered cleaned up, nearly half a million tons of depleted uranium hexafluoride stored at the site, mostly in 14-ton-capacity cylinders, will need to be addressed. This material is the by-product of the uranium enrichment process and poses potential health risks. In July 1999, DOE announced plans to build and operate—for 25 years—a facility at Paducah to convert this material to a more stable form at an estimated cost of \$1.8 billion to \$2.4 billion. However, DOE has not identified any significant uses for the material once it has been converted.

Finally, DOE's cleanup plan does not reflect the costs of decontamination and decommissioning that will be required after USEC ceases plant operations and terminates its lease with DOE. DOE has estimated in January 1998 the cost of this additional cleanup at about \$1 billion.

Mr. Chairman, as I have stated, even if DOE's January 2000 cleanup plan is followed, billions of dollars and many more years will be required to address contaminated or potentially hazardous areas that are not included in the current cleanup plan. The exclusion of these areas from the plan prevents the Congress and other stakeholders from easily ascertaining the full scope and cost of the actual cleanup task at hand. We are also concerned that if DOE does not transfer responsibility for the material storage areas and the unused structures to its Office of Environmental Management, as we recommended in our report to you, a comprehensive sitewide assessment of risks and priorities cannot be effectively completed. The Congress and stakeholders undoubtedly have expected that when the current cleanup plan has been accomplished, the site will be clean. It will not.

Mr. Chairman, this concludes my prepared statement. I will be pleased to respond to any questions that you or Members of the Committee may have.

Contact and Acknowledgement

For future contacts regarding this testimony, please contact Ms. Gary L. Jones on (202) 512-3841. Individuals making key contributions to this testimony include Erin Barlow, Daniel Feehan, Glen Trochelman, and Pam Tumler.

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